

CLAIMS

What is claimed is:

1. An analog to digital conversion system, comprising:
a first quantizer providing a first quantized output according to a system
5 analog input and according to a noise shaped feedback signal;
a second quantizer coupled with the first quantizer and providing a second
quantized output according to the first quantized output, the system analog input,
and the noise shaped feedback signal; and
a digital noise shaping system coupled with the first and second
10 quantizers and providing the noise shaped feedback signal according to the
second quantized output, the noise shaped feedback signal being noise shaped
by the digital noise shaping system with respect to a quantization error
associated with the first quantizer.
- 15 2. The system of claim 1, wherein the first quantizer is an N-level A/D
converter providing the first quantized output having one of N discrete levels,
wherein the second quantizer is an M-level A/D converter providing the second
quantized output having one of M discrete levels, M and N being integers greater
than 1, and wherein N is less than M.
- 20 3. The system of claim 2, wherein N is 3 or more and M is 64 or more.
4. The system of claim 1, wherein the second quantizer is an M-level
A/D converter providing the second quantized output having one of M discrete
25 levels, and wherein the number of levels M of the second quantizer determines a
noise floor of the analog to digital conversion system.
5. The system of claim 1, wherein the first and second quantizers are
flash A/D converters.

6. The system of claim 1, wherein the first and second quantizers individually comprise switched capacitor circuits.

7. The system of claim 1, wherein the digital noise shaping system
5 comprises a switched capacitor circuit.

8. The system of claim 7, wherein the digital noise shaping system comprises a digital bandpass filter system.

9. The system of claim 1, wherein the digital noise shaping system
10 comprises a digital bandpass filter system.

10. The system of claim 9, wherein the digital bandpass filter system comprises:

15 a first digital bandpass filter coupled with the second quantizer and providing a first filtered output according to the second quantized output;
a third quantizer coupled with the first and second quantizers and providing the noise shaped feedback signal according to the first filtered output and according to a filtered feedback; and
20 a second digital bandpass filter coupled with the first digital bandpass filter and with the third quantizer, the second digital bandpass filter providing the filtered feedback according to the noise shaped feedback signal and according to the first filtered signal.

25 11. The system of claim 9, wherein the noise shaped feedback signal is noise shaped by the digital noise shaping system with respect to a quantization error associated with the first quantizer.

12. The system of claim 1, wherein the digital noise shaping system
30 comprises:

a plurality of digital bandpass filter systems coupled with the second quantizer, the digital bandpass filter systems having different filter pole and zero locations; and

5 a multiplexer coupled between the digital bandpass filter systems and the first quantizer, the multiplexer providing the noise shaped feedback signal according to a selected one of the digital bandpass filter systems.

13. The system of claim 12, wherein the plurality of digital bandpass filter systems individually comprise:

10 a first digital bandpass filter coupled with the second quantizer and providing a first filtered output according to the second quantized output;

a third quantizer coupled with the first and second quantizers and providing the noise shaped feedback signal according to the first filtered output and according to a filtered feedback; and

15 a second digital bandpass filter coupled with the first digital bandpass filter and with the third quantizer, the second digital bandpass filter providing the filtered feedback according to the noise shaped feedback signal and according to the first filtered signal.

20 14. The system of claim 13, wherein the noise shaped feedback signal is noise shaped by the digital noise shaping system with respect to a quantization error associated with the first quantizer.

25 15. The system of claim 1, wherein the noise shaped feedback signal is noise shaped by the digital noise shaping system with respect to a quantization error associated with the first quantizer.

16. A bandpass delta sigma modulator, comprising:

30 a first quantizer providing a first quantized output according to a system analog input and according to a noise shaped feedback signal; and

a digital error feedback system coupled with the first quantizer and providing the noise shaped feedback signal according to the first quantized output.

5 17. The bandpass delta sigma modulator of claim 16, wherein the digital error feedback system comprises:

a second quantizer coupled with the first quantizer and providing a second quantized output according to the first quantized output, the system analog input, and the noise shaped feedback signal; and

10 a digital noise shaping system coupled with the first and second quantizers and providing the noise shaped feedback signal according to the second quantized output, the noise shaped feedback signal being noise shaped by the digital noise shaping system with respect to a quantization error associated with the first quantizer.

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18. The bandpass delta sigma modulator of claim 17, wherein the digital noise shaping system comprises a digital bandpass filter system.

19. The bandpass delta sigma modulator of claim 18, wherein the
20 digital bandpass filter system comprises programmable poles and zeros.

20. The bandpass delta sigma modulator of claim 18, wherein the digital bandpass filter system comprises:

25 a first digital bandpass filter coupled with the second quantizer and providing a first filtered output according to the second quantized output;

a third quantizer coupled with the first and second quantizers and providing the noise shaped feedback signal according to the first filtered output and according to a filtered feedback; and

30 a second digital bandpass filter coupled with the first digital bandpass filter and with the third quantizer, the second digital bandpass filter providing the

filtered feedback according to the noise shaped feedback signal and according to the first filtered signal.

21. The bandpass delta sigma modulator of claim 18, wherein the noise
5 shaped feedback signal is noise shaped by the digital noise shaping system with respect to a quantization error associated with the first quantizer.

22. The bandpass delta sigma modulator of claim 18, wherein the digital noise shaping system comprises:

10 a plurality of digital bandpass filter systems coupled with the second quantizer, the digital bandpass filter systems having different filter pole and zero locations; and

a multiplexer coupled between the digital bandpass filter systems and the first quantizer, the multiplexer providing the noise shaped feedback signal
15 according to a selected one of the digital bandpass filter systems.